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I am submitting herewith a thesis written by Joseph Randolph Taylor entitled "The Effect of Feeding Urea and Stilbestrol on Ration Digestibility and on Calcium, Phosphorus and Nitrogen Retention in Lambs." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Husbandry.

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THE EFFECT OF FEEDING UREA AND STILBESTROL ON RATION DIGESTIBILITY
AND ON CALCIUM, PHOSPHORUS AND NITROGEN RETENTION IN LAMBS

A THESIS

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Joseph Randolph Taylor



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CHAPTER I

INTRODUCTION

Considerable information may be derived through the use of digestion and balance studies in determining the utilization of feed nutrients by livestock. Micro-organisms found in the gastro-intestinal tract of ruminants do a large part of the digestion, which results in the production of various nutrients that are necessary for the proper growth of the body. As an example, urea nitrogen may be broken down by these bacteria to be used to produce some of the essential amino acids for body growth.

For a number of years, organic forms of nitrogen have been substituted for a part of the protein requirements for ruminants. Commercial urea, which contains nitrogen equivalent to 262 percent crude protein, is the common form of organic nitrogen fed to livestock. Many experiments have been conducted to study the feeding value and use of urea as a protein substitute.

Recently, considerable work has been devoted to study the value of stilbestrol for fattening farm livestock. Stilbestrol is a synthetic chemical compound with estrogenic properties which has been shown to have some effect on rate of gain, feed efficiency and carcass quality with some classes of livestock. There is very little information regarding the metabolic action of this compound and its effect on urea utilization.

This investigation was conducted to determine the effect that stilbestrol had when added to the rations of chopped grass hay plus either corn and cottonseed meal or corn and urea. Digestion and balance studies were made to determine the percentage of digestibility of feed nutrients and to deter-

mine the amount of calcium, phosphorus and nitrogen that was retained by the lambs fed various rations.

CHAPTER II

REVIEW OF LITERATURE

The review of literature included in this thesis is concerned primarily with the results of experiments adding stilbestrol to rations for ruminants with some reference to material on the use of urea as a protein substitute. No reference material was found as to the effects on calcium and phosphorus retention when urea was fed in the presence of stilbestrol.

Armsby (1911) showed that the ruminant could utilize non-protein nitrogen to a limited extent. Since then, considerable work has been conducted to determine the feeding value of urea as a partial protein substitute.

Gallup et al. (1953) reported that urea is a colorless and odorless compound manufactured from coal, air and water. It resembles common salt when in the finished form. Urea cannot be used by the simple stomach animal to any appreciable extent since rumen micro-organisms are needed to convert this compound into amino acids. Hanson and Ferrin (1955) showed that pigs on a low protein ration that was supplemented with urea required 6 percent more feed per pound of gain, while the pigs on a normal protein ration gained about 16 percent more per head daily.

The amount of urea that can be fed without detrimental effect may be determined by the rate of consumption, the amount of protein to which the animals are accustomed, the length of time which the animals are fed urea and the amount of carbohydrates fed. All of these factors, according to Clark et al. (1951), affect the activity of the ruminal flora, which determine the extent of toxicity of urea in an animal. They further stated

that toxicity may be alleviated by the oral administration of acetic acid.

Bowstead and Fredeen (1948) demonstrated that urea was unpalatable, and some animals had such a dislike for it that they would continue to refuse their feed even though it was mixed with molasses or other ingredients. The same animals, however, would relish natural protein supplements.

Morrison (1949) stated that when urea is added to hay alone, without concentrates, the conversion to protein is not very satisfactory and does not furnish any energy. Parham et al. (1955) reported that animals need more feed per unit of gain when being fed urea. With the proper precautions in feeding this compound as a supplement, there likely will be no adverse physiological effects.

Since the animal body needs a considerable amount of protein for muscle building material, it is desirable to determine what feedstuffs and conditions will provide sufficient nitrogen storage for this purpose. Tillman and Swift (1952) reported that sheep receiving urea stored slightly more nitrogen than those on other protein supplements of superior quality; while Bell et al. (1953) found that when urea was added to a ration containing corn, the nitrogen retention was significantly greater than that of a molasses ration. Urea presence did not affect the apparent digestibility of the nutrients to any appreciable extent. Dinning et al. (1949) were in agreement, for they observed an increase of nitrogen retention when urea was added to a number of different rations for both steers and lambs. Gallup and Briggs (1950) reported that urea as a nitrogen supplement did not affect the retention of calcium or phosphorus. There are many more references pertaining to the use of urea as a protein supplement. Most of these are included in a review by Reid (1953).

The use of synthetic estrogens in the feeding of livestock has been advocated only in recent years. Andrews et al. (1949) was one of the first to use implants or estrogens in a feeding program. It was shown that by using twelve or twenty-four mg. stilbestrol implants in lambs that there was a significant increase in the rate of gain and less feed was required per pound of gain. Clegg et al. (1955) reported that wethers treated with stilbestrol made a significant increase in rate of gain, but there was no difference in rate of gain between animals implanted with twelve mg. from those treated with thirty-five mg.

Bell et al. (1954), Cheng and Burroughs (1954) and Jordan (1950) all reported that stilbestrol fed to ruminants resulted in better and faster gains with less feed. Perry et al. (1955) reported that steers treated with stilbestrol made their fastest growth the first twenty-eight days of the feeding period, while Clegg et al. (1955) found a significant increase in rate of gain regardless of age, sex or dietary regime by using implants. Hale et al. (1954) reported that results from the oral feeding of stilbestrol may be affected by seasonal differences.

Bell et al. (1955) reported that urea satisfactorily replaced 50 percent of the cottonseed meal in the ration fed to yearling and two-year-old steers. They found by adding ten mg. stilbestrol they could replace all of the cottonseed meal with urea and get equivalent gains to that of cottonseed meal.

Whitehair et al. (1953) showed that with twenty-four mg. stilbestrol implants there was a marked increase of nitrogen, calcium and phosphorus retention, but there was no apparent effect on the digestibility of the nutrients. The treated lambs made faster gains than the untreated ones. Clegg

and Cole (1954) found when administering stilbestrol to steers, the retention of nitrogen was almost doubled. Acker et al. (1954) reported that the feeding of two mg. per day of stilbestrol did not improve the digestibility of organic matter as determined by digestibility studies.

Cheng and Burroughs (1954) sought information regarding the metabolism of stilbestrol in the rumen and the forms in which it enters the blood stream. It was found when incubated aerobically at 40°C. for twenty-four hours with rumen fluid, that a large portion was destroyed, but when incubated under anaerobic conditions there was no appreciable loss. Also, it was discovered that heating the rumen fluid inhibited the destructive action on this compound; therefore, it appears that aerobic destruction of stilbestrol may be an enzymatic action. When this hormone is fed to cattle or sheep, there probably is no loss or transformation of the hormone in the fore stomach, since the rumen is primarily anaerobic. Liver samples were taken from the lambs and a significantly greater amount of liver dry matter and considerable less amount of liver ester cholesterol were found in the treated than in the untreated animals.

Wilkinson et al. (1954) reported that blood analysis from lambs treated twenty-three days with fifteen mg. stilbestrol implants showed that they had a lower hematocrit and higher fibrinogen and plasma free cholesterol than did the control lambs.

Perry et al. (1955) noticed that the feeding of stilbestrol to steers resulted in an elevation of the tail head, some relaxation of the lumbar vertebrae and an increase in the length of the teats; while Whitehair et al. (1953) reported that lambs became nervous and restless, with an increase in

the size of the mammary gland and teats as a result of feeding stilbestrol.

Using an excessive amount of stilbestrol (thirty mg. implants), Bell et al. (1954) lost several lambs in their feeding experiment due to prolapse of the rectum and excessive swelling and inflammation of the perineal region. In the same experiment, the seminal vesicles, bladder ampullae, urethra, prostate gland and the bulbo-urethral glands were enlarged. Powell (1953) reported that with twelve mg. implants of stilbestrol there was udder development and a milky fluid produced in a wether within ten days after treatment. Also, he observed both rectal and vaginal prolapse at the end of the forty-second day of the experiment.

According to Perry et al. (1955), when steers that had been consuming ten mg. stilbestrol daily were slaughtered, there was no significant estrogenic activity revealed in the assay of the meat. Hale et al. (1954) reported that stilbestrol administered orally did not appear to have any appreciable effect upon carcass quality of lambs.

It has been shown by Dinning et al. (1949), Tillman and Swift (1950) and Bell et al. (1953) that when a low protein ration was supplemented with urea, there was generally a greater retention of nitrogen. At the same time, it has been reported by Whitehair et al. (1953) and Clegg and Cole (1954) that by adding a few mg. stilbestrol to the ration there was an increase of nitrogen retention, but the literature does not reveal any work on supplementation of both urea and stilbestrol to the ration for lambs.

Schilling et al. (1950) found a definite retention of calcium, phosphorus and nitrogen when estrogens were administered in man with body disturbances. Taurog et al. (1944) found a significant increase of phosphorus

metabolism with stilbestrol in vitro formation of radiophospholipids of the liver of birds. Govaerts et al. (1951) reported that with daily administering of estrogens the calcium metabolism of the body was greatly increased.



CHAPTER III

EXPERIMENTAL PROCEDURE

This experiment was conducted to study the effect urea and stilbestrol had on ration digestibility and on the nitrogen, calcium and phosphorus retention when administered orally to one-year-old Hampshire wethers. The digestibility studies were conducted on crude protein, crude fiber, nitrogen free extract and ether extract.

Sixteen wethers were obtained from the station for this experiment. Twelve of these wethers were selected and placed in the barn and fed for fourteen days in individual feed stanchions for the purpose of becoming accustomed to their new environment. The wethers were fed at 3 p.m. and remained in the stanchions until 8 a.m. when they were released and allowed to run about the barn. They had free access to water during the day.

The ration fed these wethers was mixed grass hay that had been chopped and a grain mixture. Table I shows the average percentage composition of the ration. The grain used was number two crushed yellow corn. The cottonseed meal used was of the expeller process which contained 41 percent crude protein, and the urea was feed urea containing 262 percent crude protein. The wethers were fed the same grain mixture as shown in Table II and the mixed grass hay for the entire experiment.

At the end of fourteen days, the wethers were divided into four lots, as shown in Table III, based on weight and uniformity. Then the wethers were transferred to metabolism stalls which were a modification of the stalls described by Briggs and Gallup (1949). For the first few days in the metabolism stalls their feed consumption decreased, but all except one wether

TABLE I

AVERAGE PERCENTAGE COMPOSITION OF FEEDS

Feed	Dry Matter	Crude Protein	Ether Extract	Crude Fiber	NFE	Ash
Mixed grass hay	90.8	9.3	1.2	35.4	39.8	4.9
Corn, cottonseed meal	87.8	13.4	4.2	2.5	64.9	2.8
Corn, urea	87.5	13.5	3.5	1.6	66.5	2.4

TABLE II
GRAIN MIXTURE

Mixture 1		Mixture 2	
Corn	85.5	Corn	96.85
Cottonseed meal	13.0	Urea	1.65
Calcium carbonate	1.0	Calcium carbonate	1.00
Salt	<u>0.5</u>	Salt	<u>0.50</u>
Total	100.0	Total	100.00

TABLE III

RATION TREATMENT AND EFFECT OF STILBESTROL
AND UREA ON RATE OF GAIN

Lot number Treatment	I Corn, CSM, Grass hay	IIa Corn, CSM, Grass hay	III Corn, Urea, Grass hay	IVa Corn, Urea, Grass hay
Number of wethers	2	4	2	4
Weights (lbs.)				
Average initial	98.4	95.9	99.6	96.7
Average final	107.0	106.5	99.0	104.0
Total gains (46 days)	8.6	10.6	-0.6	7.3
Amount feed consumed (lbs.)				
Mixed grass hay	1.00	1.00	1.00	1.00
Grain mixture	1.25	1.25	1.25	1.25
Total feed	2.25	2.25	2.25	2.25
Total percent protein	11.5	11.5	11.6	11.6

^aReceived 4 mg. stilbestrol during Trials 2 and 3.

was back on feed at the end of the seven-day period, although they did not appear to consume as much as they would under normal conditions.

After the wethers were transferred to the metabolism stalls for the collection period, an attempt was made to measure the water consumption. This was difficult due to the water facilities. The wethers would constantly turn the water containers over or take a mouth full of water and spit it out.

The experiment was divided into six trials of seven days per trial, as shown in Table IV. The urine and feces were collected daily during four trials. In Trial 1, the beginning of the collecting period, Lots I and II received 1 pound of hay and 1.25 pounds of corn and cottonseed meal mixture per head, and Lots III and IV received 1 pound of hay and 1.25 pounds of corn and urea mixture. In Trial 2, after seven days of collection, Lots II and IV were fed four mg. stilbestrol per head daily with the grain mixture. Lots I and III were fed the same feed during the entire feeding period.

In Trials 3 and 4, the wethers were removed from the metabolism stalls back to their individual feed racks and allowed a rest period of fourteen days. One of the wethers in Lot I was removed from the experiment due to the low feed consumption and lameness in the front feet, and a substitute animal was used.

Trial 5 was conducted in the same manner as Trial 2, and Trial 6 was conducted as Trial 1 to determine the carry over effect of stilbestrol. The wethers were weighed at the beginning and end of each trial.

The wethers received a constant amount of experimental ration daily.

TABLE IV

THE COTTONSEED MEAL, UREA AND STILBESTROL EXPERIMENTAL PLAN

(January 30, 1955 through March 12, 1955)

Lot number	I	II	III	IV
Number wethers per lot	2	4	2	4

METABOLISM STALLS

Trial 1				
Treatment	Corn, CSM, mixed hay	Corn, CSM, mixed hay	Corn, urea, mixed hay	Corn, urea, mixed hay
Trial 2				
Treatment	Corn, CSM, mixed hay	Corn, CSM, mixed hay, 4 mg. of stilbestrol	Corn, urea, mixed hay	Corn, urea mixed hay, 4 mg. of stilbestrol

INDIVIDUAL FEED RACKS

Trial 3 and 4				
Treatment	Corn, CSM, mixed hay	Corn, CSM, mixed hay, 4 mg. of stilbestrol	Corn, urea, mixed hay	Corn, urea, mixed hay, 4 mg. of stilbestrol

METABOLISM STALLS

Trial 5				
Treatment	Corn, CSM, mixed hay	Corn, CSM, mixed hay, 4 mg. of stilbestrol	Corn, urea, mixed hay	Corn, urea, mixed hay, 4 mg. of stilbestrol
Trial 6				
Treatment	Corn, CSM, mixed hay	Corn, CSM, mixed hay	Corn, urea, mixed hay	Corn, urea, mixed hay

They were fed the concentrate and hay at 3 p.m., and the unconsumed feed was collected, weighed and sampled the following morning at 8 a.m. Theseorts were composited and analyzed in order to determine the intake of the different nutrients per lamb.

During the collection trials, urine and feces were collected at 5 p.m. The urine was measured and a 10 percent sample, by volume, was taken. The feces was weighed and a 10 percent sample, by weight, was taken. These samples were kept in closed containers. At the end of seven days collection, the samples were thoroughly mixed and a composite sample was taken and stored under refrigeration for analysis.

In addition to the seven-day composite sample, a daily sample of urine and feces was taken during Trials 2 and 6 for the determination of nitrogen excretion only.

A 100-gram sample of feces was taken from the daily composite sample and was dried in the oven for forty-eight hours. The dry sample was taken from the oven and allowed to remain in the open air for twenty-four hours to allow the sample to return to an air dry basis. The sample was then ground, taken to the laboratory and weighed to determine the percent dry matter, and then analyzed. The determinations of all the nutrients were analyzed on the air dry feces sample. The nitrogen determination was done with a wet feces sample taken from the seven-day composite.

From the seven-day composite sample for Trials 1, 2, 5 and 6, feces and urine samples were taken and analyzed for calcium, phosphorus and nitrogen. Coefficients of digestibility were calculated for crude fiber, crude protein, nitrogen free extract and ether extract. For the same four trials, balance studies for calcium, phosphorus and nitrogen were conducted.

Nitrogen, crude fiber, ash and moisture analyses were made by the A.O.A.C. Method (1950), and the fat analysis was determined by a slight modification of the A.O.A.C. Method. The nitrogen free extract content was calculated by subtraction of the sum of the percentages of crude protein, fat, crude fiber, ash and moisture from 100.

The calcium analysis was determined by a modification of the method of Brown et al. (1950), and the phosphorus was determined by a modification of the method of Fiske and Subbarow (1925).

CHAPTER IV

RESULTS AND DISCUSSION

The results of this experiment with wethers comparing urea with cottonseed meal, urea and stilbestrol with cottonseed meal and stilbestrol, urea with urea and stilbestrol, and cottonseed meal with cottonseed meal and stilbestrol, showed a significantly greater digestibility of crude protein and a significantly less digestibility of ether extract from the rations containing the urea, as shown in Table V and Appendix Table X. The stilbestrol had no apparent effect upon the digestibility of the ration nutrients as shown in Table V. The average daily apparent coefficients of digestibility of rations for the individual wethers are shown in Appendix Table XI. This is in agreement with results obtained by Whitehair et al. (1953) who used stilbestrol implants instead of feeding stilbestrol.

It has been shown by Whitehair et al. (1953) and Clegg and Cole (1954) that with the addition of a few mg. of stilbestrol to the ration, the retention of nitrogen was greatly increased. This is in agreement with what is reported in Table VI. The feeding of stilbestrol significantly increased the daily nitrogen retention during the first seven days (4.9 vs. 3.3) and the greater retention continued as long as the wethers received the stilbestrol. It is shown in Table VI that the nitrogen retention for Lot II, Trial 2 was 4.91 g. as compared to Trial 1, with no stilbestrol, where the nitrogen retention was 2.47 g. In Trial 5, after the wethers had continued to receive 4 mg. of stilbestrol for four weeks, the nitrogen balance was 5.58 g. as compared to Trial 1 with a 2.47 g. nitrogen balance. After discontinuing the stilbestrol treatment in Lot II

TABLE V

AVERAGE APPARENT COEFFICIENTS OF DIGESTIBILITY OF RATIONS

Protein Supplement	Trial Number	Lot Number	Dry Matter		Crude Protein		Ether Extract		Crude Fiber		NFE	
			I	II	I	II	I	II	I	II	I	II
Cottonseed Meal	1		71.0	71.5	57.3	61.6	83.4	83.3	45.1	46.8	82.0	82.7
	2		71.5	73.0 ^a	64.6	66.8 ^a	86.9	86.4 ^a	47.4	46.6 ^a	81.4	82.2 ^a
	5		72.0	69.7 ^a	65.3	66.8 ^a	80.1	86.4 ^a	51.5	46.6 ^a	81.4	82.2 ^a
	6		71.0	73.0	63.5	68.3	80.9	81.8	50.3	57.7	81.4	83.4
	Average		71.4	71.8	62.7	65.9	83.1	84.5	48.6	49.4	81.6	82.6
Urea		Lot Number	III	IV	III	IV	III	IV	III	IV	III	IV
	1		74.0	73.5	69.5	65.5	83.0	79.9	51.5	49.7	82.9	82.4
	2		72.5	73.0 ^a	72.9	69.8 ^a	78.3	82.8 ^a	47.5	46.3 ^a	81.7	82.4 ^a
	5		71.5	71.0 ^a	69.2	68.6 ^a	76.1	72.6 ^a	43.1	49.0 ^a	82.2	80.6 ^a
	6		76.5	75.5	73.3	71.3	82.1	80.6	50.2	57.0	86.2	83.8
	Average		73.6	73.2	71.2	68.8	79.9	79.0	48.1	50.5	83.2	82.3

^a Stilbestrol fed at the rate of 4 mg. per day.

TABLE VI

AVERAGE DAILY NITROGEN BALANCE FOR WETHERS

Lot Number	Trial Number	Dry Matter	Nitrogen Consumed	Nitrogen excreted		Total Nitrogen Excreted	Nitrogen Balance
				Urine	Feces		
I	1	751	15.68	7.72	6.63	14.35	1.33
	2	871	18.39	8.15	6.52	14.67	3.72
	5	844	17.92	9.08	6.23	15.31	2.61
	6	909	18.48	8.52	6.71	15.23	3.25
	Average	844	17.62	8.37	6.52	14.89	2.48
II	1	878	17.81	8.53	6.81	15.34	2.47
	2 ^a	858	18.07	7.16	6.00	13.16	4.91
	5 ^a	903	19.33	7.40	6.35	13.75	5.58
	6	874	17.79	8.06	5.68	13.74	4.05
	Average	878	18.25	7.79	6.21	14.00	4.25
III	1	867	17.27	10.19	5.29	15.48	1.79
	2	888	18.63	10.74	5.04	15.78	2.85
	5	836	17.61	8.71	5.46	14.17	3.44
	6	815	17.41	8.82	4.67	13.49	3.92
	Average	852	17.73	9.62	5.12	14.73	3.00
IV	1	830	16.75	8.81	5.78	14.59	2.16
	2 ^a	861	18.82	8.32	5.65	13.97	4.85
	5 ^a	903	18.98	8.72	5.99	14.71	4.27
	6	906	18.99	8.97	5.45	14.42	4.57
	Average	875	18.39	8.71	5.72	14.42	3.96

^aStilbestrol fed at the rate of 4 mg. per day.

of Trial 6, it is shown that the nitrogen balance dropped from 5.58 g. to 4.05 g., which is still higher than the control group of Lot I. Appendix Table XII shows the average daily nitrogen balance for individual wethers.

When feeding urea and stilbestrol, the nitrogen retention showed the same trend as that of cottonseed meal and stilbestrol by increasing, as shown in Table VI, Lot IV, Trial 2. In Trial 5, the nitrogen balance dropped for some cause, but remained higher than Lot III, which was the control. In Trial 6, when the stilbestrol had been discontinued from the urea ration, the nitrogen balance was higher than Trial 5, but less than Trial 2.

In Appendix Table IX, it is shown that there was no statistical significance in the nitrogen balance when comparing urea with cottonseed meal supplements. When stilbestrol was added to the ration, comparing cottonseed meal and urea to the non-stilbestrol group in Trial 2 and Trial 5, the differences were highly significant at the 1 percent level. It is observed in this table that with the presence of stilbestrol, there was a statistical difference in the nitrogen retention or approaching significance in all lots except Lot II in Trial 5 and Lot IV of Trial 5.

These results indicate there does not seem to be a residual effect of stilbestrol on the nitrogen retention. This retention of nitrogen when wethers were fed stilbestrol was found to be due to a decrease in the amount of nitrogen excreted in the urine as shown in Table VI. It is assumed that by getting faster gains when consuming stilbestrol that the animals are utilizing this extra nitrogen efficiently.

Stilbestrol had somewhat of a different effect upon the metabolism of calcium and phosphorus. It has been shown that with the addition of stilbestrol, the increase of nitrogen retention was immediate as shown in

Table VI. Comparing Trial 2 with Trial 1 in Lot II, it is shown that with stilbestrol the nitrogen retention almost doubled during the first seven days, and in Trial 2 compared with Trial 1 of Lot IV, the retention of nitrogen was doubled when stilbestrol was added. Table VII shows that with stilbestrol, the calcium balance was reversed to that of the nitrogen balance.

As shown in Table VII, the average calcium balance in Trial 5 for the wethers receiving stilbestrol was 1.3 g. as compared to 0.3 g. for the wethers on the non-stilbestrol ration. It was found in Trial 1 of Lot I that there was a negative calcium and phosphorus balance which may have been due to one animal refusing to consume the ration at the beginning of the experiment.

In Lot II, Trial 2, where the wethers were receiving stilbestrol, the first seven-day period showed a decrease in calcium retention as compared to Trial 1 where there was no stilbestrol added to the ration. In Lot IV, Trial 2 compared to Trial 1 showed the same trend as that found in Lot II. Trial 5 in both Lot II and Lot IV showed a big increase in the retention of calcium when stilbestrol had been fed for a period of twenty-eight days. This may indicate a continued build-up of its effect.

Table VII, Trial 6 of both Lots II and IV shows that the calcium balance was higher than the averages of Lots I and III, the control groups. However, the calcium retention was reduced considerably as compared with the previous seven days. With these results, it indicates a carry-over effect after discontinuing stilbestrol in the ration. Appendix Table XIII shows the average daily calcium balance for the individual wethers.

Table VIII shows the average phosphorus balance for the four trials.

TABLE VII

AVERAGE DAILY CALCIUM BALANCE (GRAMS)

Lot Number	Trial Number	Dry Matter	Calcium Consumed	Calcium excreted		Total Calcium Excreted	Calcium Balance
				Urine	Feces		
I	1	751	2.15	.04	2.28	2.32	-.17
	2	871	2.36	.02	2.32	2.34	.02
	5	844	2.47	.03	1.97	2.00	.47
	6	909	2.39	.04	2.29	2.33	.06
	Average	844	2.34	.03	2.22	2.25	.10
II	1	878	2.74	.05	2.37	2.42	.33
	2 ^a	858	2.26	.03	2.12	2.15	.11
	5 ^a	903	2.84	.01	1.63	1.64	1.20
	6	874	2.22	.03	1.63	1.66	.56
	Average	878	2.52	.03	1.94	1.97	.55
III	1	867	2.76	.07	2.36	2.43	.33
	2	888	2.65	.05	2.52	2.57	.08
	5	836	2.68	.02	1.99	2.01	.67
	6	815	2.23	.06	2.06	2.12	.11
	Average	852	2.58	.05	2.23	2.28	.30
IV	1	830	2.97	.03	2.05	2.08	.89
	2 ^a	861	2.41	.02	2.13	2.15	.26
	5 ^a	903	3.01	.02	1.55	1.57	1.44
	6	906	2.54	.03	2.08	2.11	.43
	Average	875	2.73	.03	1.95	1.98	.76

^a Stilbestrol fed at the rate of 4 mg. per day.

TABLE VIII

AVERAGE DAILY PHOSPHORUS BALANCE (GRAMS)

Lot Number	Trial Number	Dry Matter	Phosphorus Consumed	Phosphorus excreted		Total Phosphorus Excreted	Phosphorus Balance
				Urine	Feces		
I	1	751	2.10	.01	2.21	2.22	-.12
	2	871	2.34	.01	2.29	2.30	.04
	5	844	2.34	.03	1.96	1.99	.35
	6	909	2.50	.01	2.34	2.35	.15
	Average	854	2.32	.02	2.20	2.22	.11
II	1	878	2.38	.01	2.33	2.34	.04
	2 ^a	858	2.27	.01	2.16	2.17	.10
	5 ^a	903	2.55	.02	1.43	1.45	1.10
	6	874	2.42	.02	1.84	1.86	.56
	Average	878	2.41	.02	1.94	1.96	.45
III	1	867	1.99	.01	1.97	1.98	.01
	2	888	1.99	.01	1.91	1.92	.07
	5	836	1.95	.01	1.64	1.65	.30
	6	815	1.87	.01	1.65	1.66	.21
	Average	852	1.95	.01	1.79	1.80	.15
IV	1	830	1.94	.01	1.90	1.91	.03
	2 ^a	861	1.91	.01	1.80	1.81	.10
	5 ^a	903	2.15	.01	1.12	1.13	1.02
	6	906	2.09	.01	1.41	1.42	.67
	Average	875	2.02	.01	1.56	1.57	.46

^a Stilbestrol fed at the rate of 4 mg. per day.

These data show that the phosphorus balance followed the same pattern as the calcium balance, for there was no apparent difference the first seven days between stilbestrol feeding and the non-stilbestrol feeding. These data also show that there was very little calcium or phosphorus excreted in the urine, and the primary effect of stilbestrol was on fecal calcium and phosphorus.

In Table VIII, Trial 2 of Lots II and IV shows that during the first seven days of feeding stilbestrol, there was no apparent effect upon the retention of phosphorus as compared to Trial 1 of the same lots. Trial 5 shows a significant increase in the retention of phosphorus in both Lots II and IV. Lot II of Trial 5 shows the phosphorus retention was 1.10 g. as compared to .04 g. in Trial 1 of the same lot, and Lot IV of Trial 5 results in a 1.02 g. retention as compared to .03 g. of Trial 1. Appendix Table XIV shows the average daily phosphorus balance for the individual wethers.

The statistical analysis of Appendix Table IX shows that urea compared to cottonseed meal did not have any effect upon the retention of calcium or phosphorus during the forty-two-day period of the experiment. The results of the calcium and phosphorus metabolism were similar throughout the experiment. This table shows there was no significant effect upon the retention of calcium and phosphorus until Trial 5 of Lots II and IV as compared to Lots I and III, which was significant at the 1 percent level. Trial 6 of the same lots resulted in an increased retention of both calcium and phosphorus at the 1 percent level. This indicates a carry-over effect.

With this greater retention of nitrogen, calcium and phosphorus when feeding stilbestrol, the animals may be able to utilize these nutrients more efficiently, making faster bone and body growth with the result of reaching

the market much sooner than under normal feeding. These data along with the data showing greater water and less fat content of the tissues of ruminants fed stilbestrol, as shown by Wilkinson et al. (1955), indicate a stimulation to growth. During normal growth there is a greater percentage of laydown of minerals, water and nitrogen when growth is compared with fattening.

After the first trial of the experiment, when the animals received the stilbestrol, they became nervous and excitable which is in agreement with observations of Whitehair et al. (1953). The wethers began to clean up their feed more regularly when being fed stilbestrol. The animals on stilbestrol showed signs of some swelling around the rectum, which appeared moist with a dark purplish color in contrast to the pink color that is normally observed. It was noticed during the fourth and fifth trials that the teats of these wethers had lengthened, and two animals were producing a fluid-like substance similar to milk in appearance. A few of the wethers receiving stilbestrol appeared to be passing an excessive amount of gas.

SUMMARY

Twelve wethers fed a fattening type of ration were used in a series of digestion and balance studies. The following comparisons were made: (1) urea vs. cottonseed meal, (2) urea and stilbestrol vs. cottonseed meal and stilbestrol, (3) urea vs. urea and stilbestrol, and (4) cottonseed meal vs. cottonseed meal and stilbestrol. This study was divided into six seven-day periods. Standard urinary and fecal collections were taken during the first, second, fifth and sixth periods.

A significantly greater digestibility of crude protein and significantly less digestibility of ether extract were found from lambs fed rations containing urea as compared with those fed rations containing cottonseed meal. Urea feeding had no noticeable effect on the retention of calcium, phosphorus or nitrogen.

Stilbestrol was fed at the rate of 4 mg. per head daily during the second, third, fourth and fifth trials. Stilbestrol feeding had no significant effect on the digestibility of ration nutrients. The feeding of stilbestrol significantly increased the daily nitrogen retention during the first seven days (4.9 g. vs. 3.3), but there was no carry-over effect after stilbestrol feeding was discontinued. Stilbestrol feeding significantly increased calcium and phosphorus retention during the last seven days (1.3 g. vs. 0.6 g. for calcium; and 1.1 g. vs. 0.3 g. for phosphorus), and there was a significant carry-over effect after stilbestrol feeding was stopped. These results show that urea can be utilized as a protein substitute and that stilbestrol feeding, under the conditions of this metabolism test, increased the retention of calcium, phosphorus and nitrogen by lambs.

BIBLIOGRAPHY

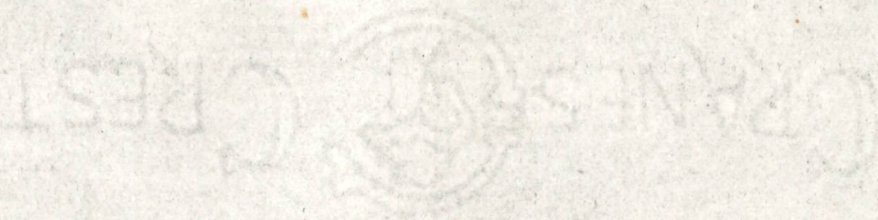


BIBLIOGRAPHY

- Acker, Duane, J. V. Whiteman, W. D. Gallup and A. D. Tillman. 1954. Effect of Certain Hormones on Feed Digestibility, Feed Lot Performance, and Carcass Quality of Lambs. Okla. Exp. Stat. Bul. No. MP- 43:42.
- Andrews, F. N., W. M. Beeson and Claude Harper. 1949. The Effect of Stilbestrol and Testosterone on the Growth and Fattening of Lambs. Jour. Animal Sci. 8:581.
- Armsby, H. P. 1911. The Nutritive Value of the Non-protein of Feeding Stuffs. U. S. Dept. Agr. Bur. An. Ind. Bul. 139.
- Association of Official Agricultural Chemists. 1950. Book of Methods. 6th Edition.
- Bell, T. Donald, Walter H. Smith and A. B. Erhart. 1954. The Effect of Stilbestrol upon Lamb Performance in the Feed Lot. Jour. An. Sci. 13:431.
- Bell, Marvin C., Willis D. Gallup and C. K. Whitehair. 1953. Value of Urea Nitrogen in Rations Containing Different Carbohydrate Feeds. Jour. An. Sci. 12:796.
- Bell, M. C., R. L. Murphree, R. A. Reynolds, J. M. Bird and C. S. Hobbs. 1955. The Use of Urea and Stilbestrol in Fattening Rations for Yearling and Two-year-old Steers. Proceeding of Association of Southern Agri. Workers. 52nd Convention. 62.
- Bowstead, J. E. and H. T. Fredeen. 1948. Feeding Urea to Dairy Cows with Special Reference to the Palatability of Feed Mixtures Containing Urea. Sci. Agri. 28:66-78.
- Briggs, H. M. and Willis D. Gallup. 1949. Metabolism Stalls for Wethers and Steers. Jour. An. Sci. 8:480.
- Brown, J. G., O. Lilleland and R. K. Jackson. 1925. Further Notes on the Use of Flame Method for Analysis of Plant Material for Potassium, Calcium, Magnesium and Sodium. Jour. Biol. Chem. 66:389.
- Cheng, Edward W. and Wise Burroughs. 1954. In Vitro Metabolism of Diethylstilbestrol in the Bovine Rumen. Jour. An. Sci. 13:1017. (Abstract).
- Clark, R., W. Oyaert and J. I. Quin. 1951. Studies on the Alimentary Tract of the Mexico Sheep in South Africa XXI. The Toxicity of Urea to Sheep under Different Conditions. Onderstepoort Jour. of Vet. Res. 25 (1) 78.
- Clegg, M. T. and H. H. Cole. 1954. The Action of Stilbestrol on the Growth Response in Rumen. Jour. An. Sci. 13:129.
- Clegg, M. T., Reuben Albaugh, Joseph Lucas and W. C. Weir. 1955. A Compari-

- son of the Effect of Stilbestrol on the Growth Response of Lambs of Different Age and Sex. Jour. An. Sci. 14:184.
- Dinning, James S., H. M. Briggs and Willis D. Gallup. 1949. The Value of Urea in Protein Supplements for Cattle and Sheep. Jour. An. Sci. 8:33.
- Fiske, C. and Y. Subbarow. 1925. The Colorimetric Determination of Phosphorus. J. Biol. Chem. 66:375-400.
- Gallup, Willis D., L. S. Pope and C. K. Whitehair. 1953. Urea in Ration for Cattle and Sheep. Okla. Agr. Exp. Stat. Bul. B-409:8.
- Gallup, Willis D. and H. M. Briggs. 1950. The Minimum Phosphorus Requirement of Lambs for Phosphorus Equilibrium. Jour. An. Sci. 9:430.
- Govaerts, J., M. J. Dallenagne and J. Melon. 1951. Radiocalcium as An Indicator in the Study of the Action of Estradiol on Calcium Metabolism. Endo. 48:443.
- Hale, W. H., C. D. Story, C. C. Culbertson and Wise Burroughs. 1954. Responses of Lambs Fed Varied Levels of Diethylstilbestrol. Jour. An. Sci. 13:985. (Abstract).
- Hanson, L. E. and E. F. Ferriss. 1955. The Value of Urea in A Low Protein Ration for Weaning Pigs. Jour. An. Sci. 14:47.
- Jordan, R. M. 1950. The Effect of Stilbestrol on Fattening Lambs. Jour. An. Sci. 9:386.
- Morrison, Frank B. 1949. Feeds and Feeding. 21st Edition. pp. 94. Morrison Publishing Co., Ithaca, New York.
- Parham, B. T., J. B. Frye, Jr., B. L. Kilpatrick and L. L. Rusoff. 1955. A Comparison of Ammoniated Molasses, Urea and Cottonseed Meal as a Source of Nitrogen in the Ration of Dairy Heifers. Jour. Dairy Sci. 38:667.
- Perry, T. W., W. M. Beeson, F. N. Andrews and Martin Stob. 1955. Effect on Steer Growth of Oral Administered Hormones. Flour and Feed 56:24-25.
- Powell, Fred Copeland. A Study on the Effects of Stilbestrol on the Rate of Gain and Feed Utilization in Lambs. Unpublished Masters of Science Thesis, Dept. of An. Husb. and Vet. Sci., Univ. of Tenn. June 1953.
- Reid, J. T. 1953. Urea as A Protein Replacement for Ruminants. A Review. Jour. of Dairy Sci. 36:955-996.
- Schilling, Albert, Daniel Luxlo, Judith Bellin and Estelle D. Gottesman. 1950. The Effect of Diethylstilbestrol on the Calcium, Phosphorus and Nitrogen Metabolism of Prostatic Carcinoma. Jour. Clin. Invest. 29:918.

- Taurog, Alvin, F. W. Lorenz, C. Entenman and I. L. Chaikoff. 1944. The Effect of Diethylstilbestrol on the In Vitro Formation of Phospholipids in the Liver as Measured with Radioactive Phosphorus. *Endo.* 35:483.
- Tillman, A. D. and E. W. Swift. 1952. The Utilization of Ammoniated Industry By-Products and Urea by Sheep. *Jour. An. Sci.* 12:211.
- Whitehair, C. K., Willis D. Gallup and M. C. Bell. 1953. Effect of Stilbestrol on Ration Digestibility and on Calcium, Phosphorus and Nitrogen Retention in Lambs. *Jour. An. Sci.* 12:336.
- Wilkinson, W. S., A. L. Pope, P. H. Phillips and L. E. Casida. 1954. The Influence of Diethylstilbestrol on Certain Blood and Liver Constituents of Lambs. *Jour. An. Sci.* 12:692.
- Wilkinson, W. S., C. C. O'Mary, G. D. Wilson, R. W. Bray, A. L. Pope and L. E. Casida. 1955. The Effect of Diethylstilbestrol upon Growth, Fattening and Certain Carcass Characteristics of Full-fed and Limited-fed Western Lambs. *Jour. An. Sci.* 14:877.



APPENDIX

TABLE IX

STATISTICAL ANALYSIS OF THE EFFECT STILBESTROL HAS ON
THE RETENTION OF NITROGEN, CALCIUM,
AND PHOSPHORUS OF WETHERS

Treatment	Nitrogen	Calcium	Phosphorus	Days on Experiment
Corn, CSM vs. corn, urea (protein)	Not sign.	Not sign.	Not sign.	42
Stilbestrol of Lots 2 & 4 in Trials 2 & 5 vs. non-stilbestrol of Lots 1 & 3 in Trials 2 & 5	Greater ^b	Not sign.	Approach. sign.	30
Stilbestrol of Lots 2 & 4 in Trials 2 vs. non-stilbestrol of Lots 1 & 3 of Trial 2	Greater ^b	Not sign.	Not sign.	14
Stilbestrol of Lots 2 & 4 in Trial 5 vs. non-stilbestrol of Lots 1 & 3 in Trial 5	Approach. sign.	Greater ^b	Greater ^b	30
Lots 2 & 4 in Trial 6 vs. Lots 1 & 3 in Trial 6 (no stilbestrol fed)	Not sign.	Greater ^b	Greater ^b	42
Stilbestrol of Lot 2 in Trial 2 vs. non-stil- bestrol of Lot 1 in Trial 2	Approach sign.	Not sign.	Not sign.	14
Stilbestrol of Lot 4 in Trial 2 vs. non- stilbestrol of Lot 3 in Trial 2	Greater ^b	Not sign.	Not sign.	14
Stilbestrol of Lot 2 in Trials 2 & 5 vs. non-stilbestrol of Lot 1 in Trials 2 & 5	Greater ^a	Not sign.	Not sign.	30

TABLE IX

STATISTICAL ANALYSIS OF THE EFFECT STILBESTROL HAS ON
THE RETENTION OF NITROGEN, CALCIUM AND
PHOSPHORUS OF WETHERS (continued)

Treatment	Nitrogen	Calcium	Phosphorus	Days on Experiment
Stilbestrol of Lot 4 in Trials 2 & 5 vs. non-stilbestrol of Lot 3 in Trials 2 & 5	Greater	Not sign.	Not sign.	30
Stilbestrol of Lot 2 in Trial 5 vs. non- stilbestrol of Lot 1 in Trial 5	Not sign.	Greater ^b	Greater ^a	30
Stilbestrol of Lot 4 in Trial 5 vs. non- stilbestrol of Lot 3 in Trial 5	Not sign.	Greater ^a	Not sign.	30
Lot 2 in Trial 6 vs. Lot 1 in Trial 6	Not sign.	Greater ^a	Not sign.	42
Lot 4 in Trial 6 vs. Lot 3 in Trial 6	Not sign.	Greater ^a	Sign. ^a	42

^aStatistical difference at the 5 percent level.

^bStatistical difference at the 1 percent level.

TABLE X

STATISTICAL ANALYSIS OF THE DIGESTIBILITY OF
UREA VS. COTTONSEED MEAL

Dry Matter	Crude Protein	Crude Fiber	Ether Extract
Not sign.	Greater ^a	Not sign.	Less ^a

^aStatistical difference at the 1 percent level.

TABLE XI

AVERAGE DAILY APPARENT COEFFICIENT OF DIGESTIBILITY OF
RATIONS FED INDIVIDUAL WETHERS

Lot Number	Trial Number	Animal Number	Dry Matter	Crude Protein	Ether Extract	Crude Fiber	NFE	
I	1	1	71	56.0	82.4	46.8	81.8	
		2	71	58.4	84.4	43.5	82.1	
	2	1	72	65.0	86.6	46.7	81.9	
		2	71	64.2	87.1	47.4	80.9	
	5	1	71	64.1	79.5	53.0	80.2	
		2	73	66.6	80.7	50.0	82.5	
	6	1	72	62.9	81.3	51.3	82.1	
		2	70	64.2	80.5	49.2	80.6	
	II	1	3	72	58.1	82.8	53.0	81.8
			4	69	63.6	83.8	47.2	78.2
5			73	62.4	85.3	49.4	83.5	
6			72	62.2	81.7	37.6	87.1	
2 ^a		3	74	64.7	88.2	53.9	82.5	
		4	71	69.5	85.8	41.4	81.4	
		5	73	68.3	88.1	43.8	83.6	
		6	71	64.8	83.5	47.3	81.3	
5 ^a		3	69	65.6	79.2	45.7	78.4	
		4	68	66.8	79.7	41.5	78.3	
		5	71	67.9	80.4	46.7	80.9	
		6	71	68.2	78.2	48.1	80.3	
6		3	73	64.8	81.6	56.3	82.0	
		4	74	67.6	81.1	56.0	82.1	
		5	78	70.4	83.8	56.3	86.7	
		6	77	70.6	80.7	62.3	84.2	

^aStilbestrol fed at rate of 4 mg. per day.

TABLE XI

AVERAGE DAILY APPARENT COEFFICIENT OF DIGESTIBILITY OF
RATIONS FED INDIVIDUAL WETHERS (continued)

Lot Number	Trial Number	Animal Number	Dry Matter	Crude Protein	Ether Extract	Crude Fiber	NFE
III	1	7	77	72.0	83.9	55.7	85.1
		8	71	67.0	82.0	47.2	80.7
	2	7	75	73.7	79.6	50.5	84.1
		8	70	72.2	76.9	44.4	79.2
	5	7	75	72.1	78.6	45.0	84.8
		8	68	66.3	73.7	41.1	79.3
	6	7	79	74.8	84.6	46.1	88.4
		8	74	71.8	79.7	54.2	84.1
	1	9	75	66.6	79.5	54.9	83.9
		10	73	62.6	78.1	37.8	83.2
		11	73	68.8	82.4	49.8	82.4
		12	73	64.1	79.6	56.3	81.7
IV	2 ^a	9	71	67.5	81.5	45.4	80.6
		10	75	70.8	82.7	46.3	84.0
		11	74	71.9	85.7	45.7	83.2
		12	72	68.9	81.4	47.7	81.7
	5 ^a	9	70	67.3	74.4	47.1	79.8
		10	69	66.5	69.3	43.9	79.3
		11	73	69.9	75.7	54.5	82.3
		12	72	70.8	72.1	50.5	80.9
	6	9	75	70.8	80.9	57.2	83.0
		10	75	70.4	78.7	54.5	83.6
		11	77	73.5	81.5	59.5	84.7
		12	75	70.6	81.2	56.6	84.0

^a Stilbestrol fed at rate of 4 mg. per day.

TABLE XII

AVERAGE DAILY NITROGEN BALANCE OF INDIVIDUAL WETHERS (GRAMS)

Lot Number	Trial Number	Animal Number	Nitrogen Consumed	Nitrogen excreted		Total Nitrogen Excreted	Nitrogen Balance
				Urine	Feces		
I	1	1	16.75	7.56	7.20	14.76	1.99
		2	14.61	7.87	6.05	13.92	.69
	2	1	19.21	8.60	6.75	15.35	3.86
		2	17.57	7.69	6.28	13.97	3.60
	5	1	19.22	7.21	6.89	14.10	5.12
		2	16.62	10.94	5.57	16.51	.11
	6	1	18.48	7.82	6.83	14.65	3.83
		2	18.48	9.22	6.58	15.80	2.68
II	1	3	16.95	7.32	7.10	14.42	2.53
		4	18.27	8.49	6.66	15.15	3.12
		5	17.69	8.53	6.55	15.08	2.61
		6	18.34	9.76	6.91	16.67	1.67
	2 ^a	3	17.95	6.13	6.33	12.46	5.49
		4	18.00	7.30	5.49	12.79	5.21
		5	17.25	7.88	5.46	13.34	3.91
		6	19.07	7.31	6.71	14.02	5.05
	5 ^a	3	19.33	7.18	6.65	13.83	5.50
		4	19.33	6.57	6.41	12.98	6.35
		5	19.33	7.67	6.20	13.87	5.46
		6	19.33	8.18	6.15	14.33	5.00
	6	3	18.48	7.63	6.51	14.14	4.34
		4	18.48	7.74	5.98	13.72	4.76
		5	15.71	9.17	4.80	13.97	1.74
		6	18.48	7.71	5.44	13.15	5.33

^aStilbestrol fed at rate of 4 mg. per day.

TABLE XII

AVERAGE DAILY NITROGEN BALANCE OF INDIVIDUAL WETHERS (GRAMS)
(continued)

Lot Number	Trial Number	Animal Number	Nitrogen Consumed	Nitrogen excreted		Total Nitrogen Excreted	Nitrogen Balance
				Urine	Feces		
III	1	7	16.32	9.67	4.57	14.24	2.08
		8	18.22	10.70	6.01	16.71	1.51
	2	7	18.20	10.51	4.78	15.29	2.91
		8	19.06	10.96	5.30	16.26	2.80
	5	7	16.24	10.24	4.53	14.77	1.47
		8	18.98	7.17	6.38	13.55	5.43
	6	7	15.77	8.20	3.97	12.17	3.60
		8	19.05	9.44	5.36	14.80	4.25
IV	1	9	17.79	8.56	6.00	14.56	3.23
		10	14.55	8.43	5.45	13.88	.67
		11	16.62	9.19	5.20	14.39	2.23
		12	18.05	9.07	6.48	15.55	2.50
	2 ^a	9	19.91	8.40	6.47	14.87	5.04
		10	17.04	7.39	4.98	12.37	4.67
		11	18.43	8.92	4.96	13.88	4.55
		12	19.91	8.56	6.18	14.74	5.17
	5 ^a	9	18.98	8.32	6.19	14.51	4.47
		10	18.98	8.74	6.36	15.10	3.88
		11	18.98	9.07	5.72	14.79	4.19
		12	18.98	8.73	5.68	14.41	4.57
	6	9	19.05	8.44	5.57	14.01	5.04
		10	19.05	9.02	5.49	14.51	4.54
		11	18.79	9.67	5.13	14.80	3.99
		12	19.05	8.73	5.60	14.33	4.72

^aStilbestrol fed at rate of 4 mg. per day.

TABLE XIII

AVERAGE DAILY CALCIUM BALANCE FOR INDIVIDUAL WETHERS (GRAMS)

Lot Number	Trial Number	Animal Number	Calcium Consumed	Calcium excreted		Total	Calcium Balance	
				Urine	Feces	Calcium Excreted		
I	1	1	2.38	.04	2.23	2.27	.11	
		2	1.92	.05	2.32	2.37	-.45	
	2	1	2.56	.02	2.32	2.34	.22	
		2	2.15	.06	2.31	2.33	-.18	
	5	1	2.82	.02	2.17	2.19	.63	
		2	2.11	.03	1.77	1.80	.31	
	6	1	2.39	.02	2.22	2.24	.15	
		2	2.39	.06	2.36	2.42	-.03	
	II	1	3	2.83	.02	2.05	2.07	.76
			4	2.75	.06	2.71	2.77	-.02
			5	2.62	.06	2.26	2.32	.30
			6	2.77	.05	2.45	2.50	.27
2 ^a		3	2.19	.01	1.76	1.77	.42	
		4	2.26	.04	2.15	2.19	.07	
		5	2.05	.03	2.06	2.09	-.04	
		6	2.53	.02	2.48	2.50	.03	
5 ^a		3	2.84	.01	1.67	1.68	1.16	
		4	2.84	.02	1.53	1.55	1.29	
		5	2.84	.01	1.57	1.58	1.26	
		6	2.84	.01	1.75	1.76	1.08	
6		3	2.39	.03	1.71	1.74	.65	
		4	2.39	.05	1.65	1.70	.69	
		5	1.71	.02	1.40	1.42	.27	
		6	2.39	.03	1.74	1.77	.62	

^aStilbestrol fed at rate of 4 mg. per day.

TABLE XIII

AVERAGE DAILY CALCIUM BALANCE FOR INDIVIDUAL WETHERS (GRAMS)
(continued)

Lot Number	Trial Number	Animal Number	Calcium Consumed	Calcium excreted		Total Calcium Excreted	Calcium Balance	
				Urine	Feces			
III	1	7	2.51	.08	2.06	2.14	.37	
		8	3.00	.05	2.66	2.71	.29	
	2	7	2.56	.03	2.20	2.23	.33	
		8	2.74	.07	2.83	2.70	-.09	
	5	7	2.34	.02	1.57	1.59	.75	
		8	3.01	.02	2.40	2.42	.59	
	6	7	1.90	.03	1.70	1.73	.17	
		8	2.55	.08	2.40	2.48	.07	
	IV	1	9	2.87	.02	2.09	2.11	.76
			10	3.00	.05	1.75	1.80	1.20
			11	3.00	.03	1.95	1.98	1.02
			12	3.00	.03	2.38	2.41	.59
2 ^a		9	2.74	.01	2.47	2.48	.26	
		10	1.76	.02	1.59	1.61	.15	
		11	2.36	.03	2.09	2.12	.24	
		12	2.74	.02	2.36	2.38	.36	
5 ^a		9	3.01	.02	1.56	1.58	1.43	
		10	3.01	.02	1.69	1.71	1.31	
		11	3.01	.01	1.52	1.53	1.48	
		12	3.01	.02	1.45	1.47	1.54	
6		9	2.55	.03	2.10	2.13	.42	
		10	2.55	.03	2.25	2.28	.27	
		11	2.49	.03	1.89	1.92	.57	
		12	2.55	.04	2.09	2.13	.42	

^aStillbestrol fed at rate of 4 mg. per day.

TABLE XIV

AVERAGE DAILY PHOSPHORUS BALANCE FOR INDIVIDUAL WETHERS (GRAMS)

Lot Number	Trial Number	Animal Number	Phosphorus Consumed	Phosphorus excreted		Total Phosphorus Excreted	Phosphorus Balance
				Urine	Feces		
I	1	1	2.26	.01	2.09	2.10	.16
		2	1.94	.01	2.32	2.33	-.39
	2	1	2.44	.01	2.21	2.22	.22
		2	2.23	.01	2.36	2.37	-.14
	5	1	2.53	.01	1.89	1.90	.63
		2	2.15	.05	2.03	2.08	.07
	6	1	2.50	.01	2.19	2.20	.30
		2	2.50	.01	2.48	2.49	.01
	II	3	2.16	.01	1.98	1.99	.17
		4	2.49	.01	2.50	2.51	-.02
		5	2.41	.01	2.38	2.39	.02
		6	2.46	.01	2.45	2.46	.00
	2 ^a	3	2.20	.01	1.74	1.75	.45
		4	2.27	.01	2.37	2.38	-.11
		5	2.19	.01	2.20	2.21	-.03
		6	2.43	.01	2.31	2.32	.11
	5 ^a	3	2.55	.06	1.12	1.18	1.37
		4	2.55	.01	1.43	1.44	1.11
		5	2.55	.01	1.48	1.49	1.06
		6	2.55	.01	1.70	1.71	.84
	6	3	2.50	.04	1.66	1.70	.80
		4	2.50	.01	1.75	1.76	.74
		5	2.16	.02	2.04	2.06	.10
		6	2.50	.01	1.90	1.91	.59

^aStillbestrol fed at the rate of 4 mg. per day.

TABLE XIV

AVERAGE DAILY PHOSPHORUS BALANCE FOR INDIVIDUAL WETHERS (GRAMS)
(continued)

Lot Number	Trial Number	Animal Number	Phosphorus Consumed	Phosphorus excreted		Total Phosphorus Excreted	Phosphorus Balance	
				Urine	Feces			
III	1	7	1.84	.01	1.73	1.74	.10	
		8	2.14	.01	2.20	2.21	-.07	
	2	7	1.92	.01	1.80	1.81	.11	
		8	2.06	.01	2.01	2.02	.04	
	5	7	1.74	.01	1.40	1.41	.33	
		8	2.15	.01	1.87	1.88	.27	
	6	7	1.64	.01	1.42	1.43	.21	
		8	2.10	.01	1.88	1.89	.21	
	IV	1	9	2.07	.01	1.78	1.79	.28
			10	1.61	.01	1.77	1.78	-.17
11			1.96	.01	1.99	2.00	-.04	
12			2.11	.01	2.07	2.08	.03	
2 ^a		9	2.06	.01	1.85	1.86	.20	
		10	1.67	.01	1.46	1.47	.20	
		11	1.83	.01	1.84	1.85	-.02	
		12	2.06	.01	2.03	2.04	.02	
5 ^a		9	2.15	.01	.95	.96	1.19	
		10	2.15	.01	1.27	1.28	.87	
		11	2.15	.01	1.23	1.24	.91	
		12	2.15	.01	1.04	1.05	1.10	
6		9	2.10	.01	1.44	1.45	.66	
		10	2.10	.01	1.37	2.38	.72	
		11	2.07	.01	1.32	1.33	.74	
		12	2.10	.01	2.53	1.54	.56	

^aStillbestrol fed at the rate of 4 mg. per day.